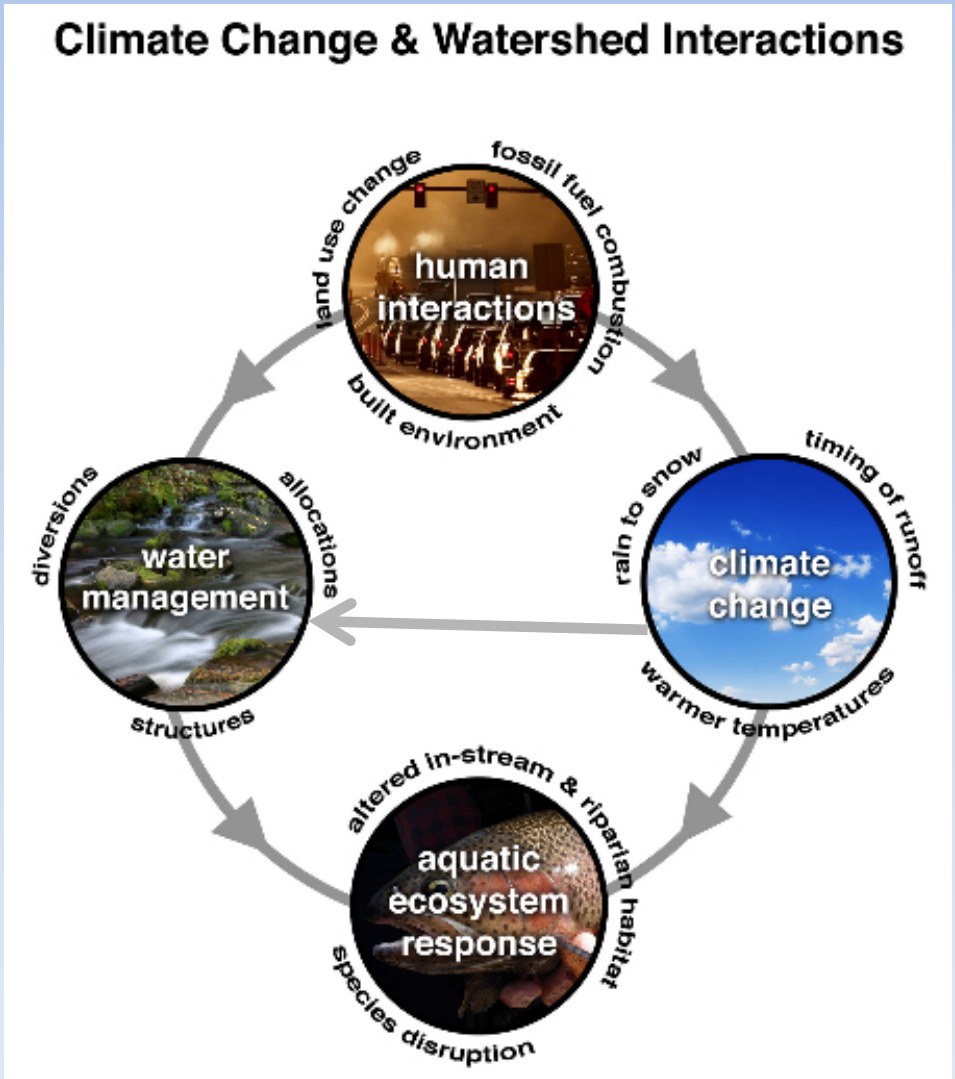
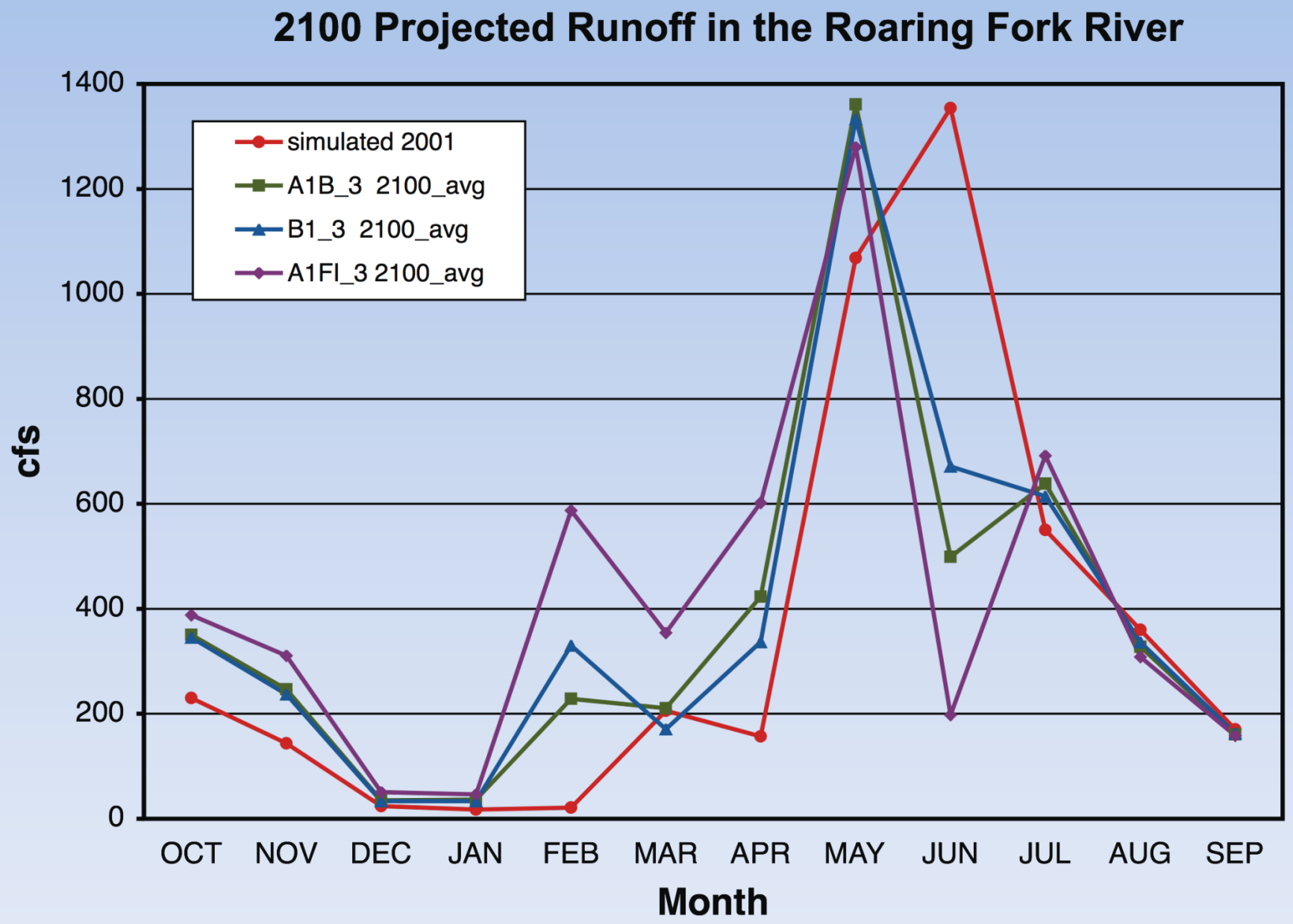
Climate Change



Key direct effects of climate change projected for the Roaring Fork Watershed are:

- Warmer temperatures,
- More precipitation as rain, with less as snow,
- Decreased snow cover and snowpack,
- Earlier snowmelt and runoff, and
- Decreased runoff.


2100 Projected Runoff in the Roaring Fork River
simulated 2001
A1B_3 2100_avg
B1_3 2100_avg
A1FI_3 2100_avg
1400
1200
1000
800
600
400
200
0
cfs
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Month

AGCI, 2006.

2012 Roaring Fork Watershed Plan Urgent Actions

- **Assess the vulnerability of the Roaring Fork Watershed to climate change.**

- **Ensure that Water Availability Studies include environmental and recreational water needs, including projected needs with climate change.**

River Center

Educating, Exciting, and Empowering People to Protect Their Rivers

The Future Depends on Us

•Climate Change will affect the form, timing, and amount of precipitation, affecting the entire water system.

•Projected population growth means more demand for water-which will exacerbate the effects of climate change.

•Climate Change has impacts throughout ecological systems of the watershed, with dramatic effects on coldwater fisheries.

•Increased efficiency, conservation, and reuse are important strategies for responding to increased demands of water and the unpredictability of supply.

- A comprehensive climate impacts assessment for the entire Roaring Fork Watershed is needed. Although the Aspen climate impacts study completed in 2006 included snowpack runoff modeling of the upper Roaring Fork Watershed, it did not incorporate full-scale hydrological modeling, and was limited in scope to impacts on the Aspen area. A watershed-wide integrated assessment would require in-depth hydrological modeling coupled to a high resolution regional climate model

- Existing watershed management plans and operational procedures should be re-evaluated to take into consideration long-term past climate variability and future climate projections related to the timing and magnitude of stream flows.

- Maintenance of existing river-related infrastructure and all new projects should incorporate future projections of stream flows based upon climate change research, and should not rely solely on interpretation of 20th century historical flow variability.

- Basic knowledge of how tightly coupled the economies of the watershed are to climate change is lacking. Research to assess the impact that significant global warming may have on present economic trends (real estate, tourism, recreation, and energy) in the watershed and beyond could help to fill this gap and lead to more sustainable economic strategies.

- Site-specific research and modeling needs to be conducted in order to understand better the complex interactions at work within the Roaring Fork Watershed (see Figure 3.5.5) and improve projections of impacts to the overall watershed.

- Gaps in the current monitoring network for physical, chemical, and biological properties of the watershed should be assessed and used to serve as the basis for developing an integrated, long-term observational database – a critical requirement for future assessments.

- Risk for aquatic systems
- How has RFC started preparing or managing these risks

- What role has science played in informing these

VITAL STATS

Area (sq. mi.) 1,453 (about the size of Rhode Island)

Height (feet) 8,518 (highest pt. Castle Peak 14,235'; lowest: Glenwood 5,717')

Population 40,000 (2005 estimate)

Counties 4

Cities/Towns 6

Miles of Stream 1,962 (42 are Gold Medal)

RFW has 25% of all the Gold Medal river miles in Colorado!

FAMILY HISTORY

Geology Rocky Mountains; stable to highly erosive soils

Topography flat rolling hills (mountainous)

Elevation Change little moderate (large)

Vegetation alpine to shrublands

Climate southern Rocky Mountain 4 seasons, dry

Water source 75% from snow

Coal Creek running gray

CURRENT HEALTH HISTORY

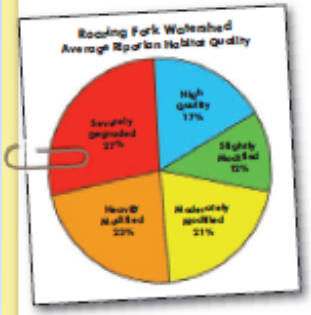
Water Quantity (flows) 67% of sites have different flows than their historic flows

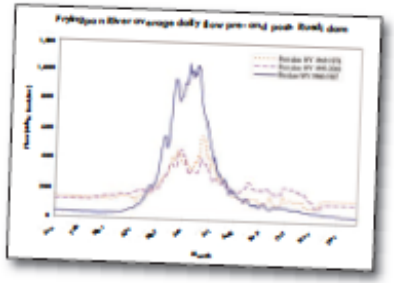
Water Quality (health) Only 26% of monitoring stations have pristine water quality

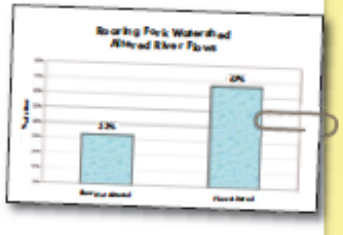
Riparian Habitat 71% moderately modified to severely degraded

Instream Habitat 82% moderately modified to severely degraded

TEST RESULTS



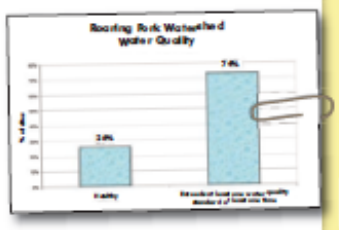




Annual Economic Impacts in Watershed

Fishing: $17 Million

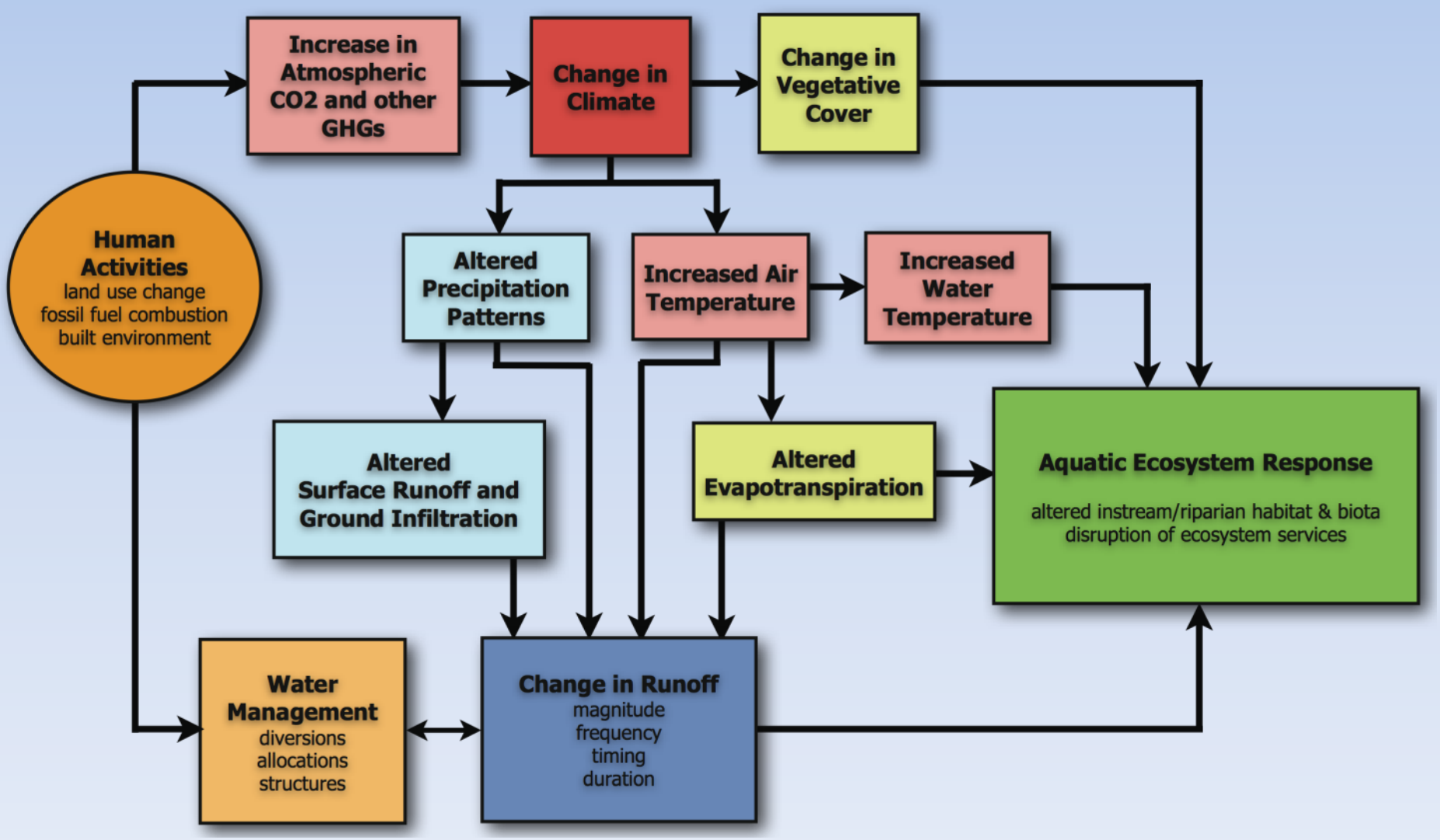
Rafting: $1-2 Million



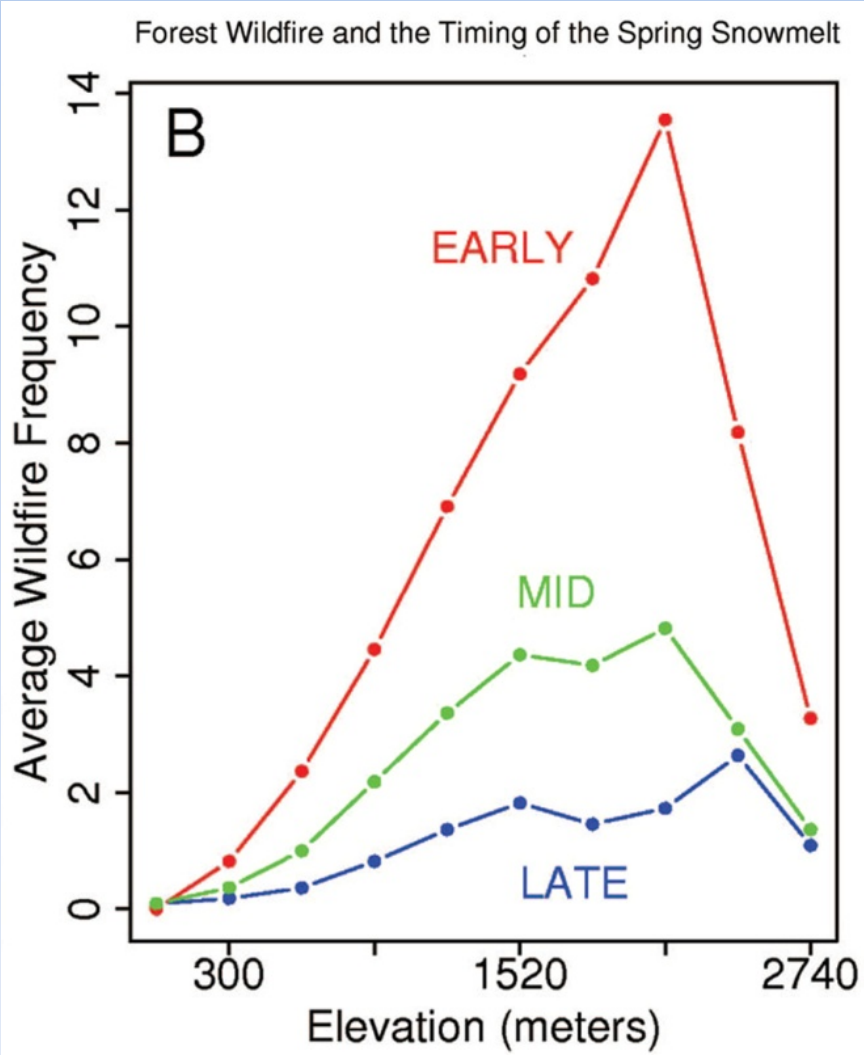
2008 State of Roaring Fork Watershed Report
Climate Change Chapter

- Higher stream temperatures
  - Increased evaporative loss
- Streamflow
  - Timing and volume
  - Correlate with DO, depth, velocity, water temperature, and food supply
  - Less dilution of pollutants
  - Loss of riparian vegetation
- More extremes weather-droughts and floods
  - Channel erosion, sedimentation, and bank stability
- Earlier drying of riparian habitats
- Increase in evapotranspiration and water demand
- Loss of trout

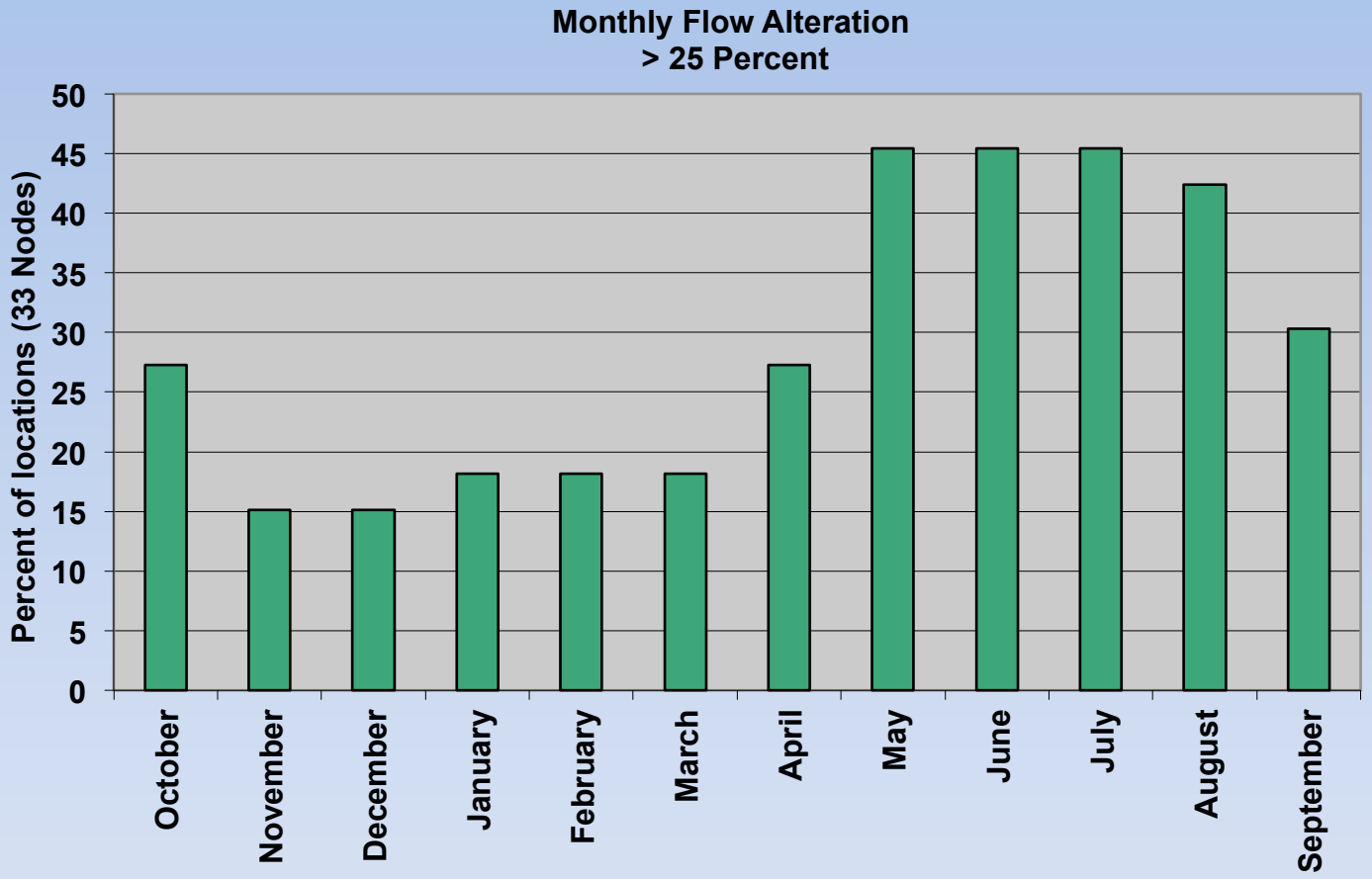
Climate Change & Watershed Interactions

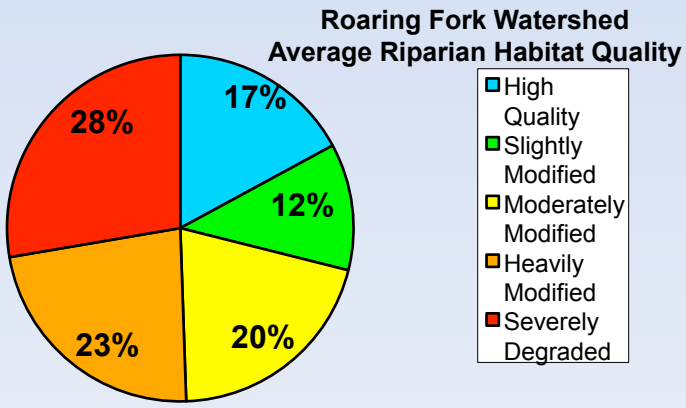


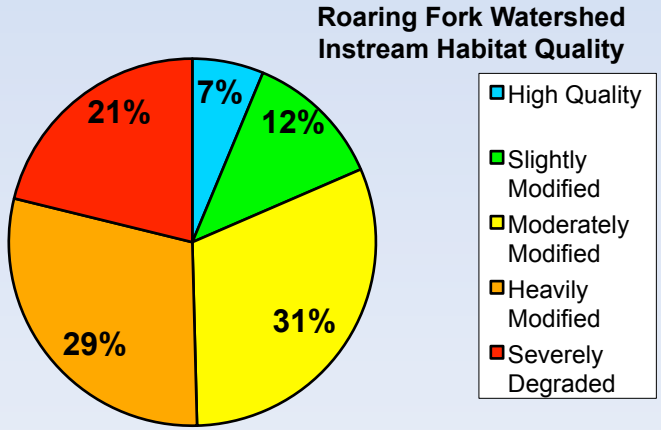
Adapted from Poff et al., 2002.



Source: Westering et al., 2006.


Monthly Flow Alteration
> 25 Percent
Percent of locations (33 Nodes)
50
45
40
35
30
25
20
15
10
5
0
October
November
December
January
February
March
April
May
June
July
August
September


Roaring Fork Watershed
Average Riparian Habitat Quality
17%
12%
20%
23%
28%
High Quality
Slightly Modified
Moderately Modified
Heavily Modified
Severely Degraded


Roaring Fork Watershed
Instream Habitat Quality
7%
12%
31%
29%
21%
High Quality
Slightly Modified
Moderately Modified
Heavily Modified
Severely Degraded

- The state's population of 5 million is expected to increase to almost 8 million by 2030.

- Eighty percent of the state's population lives in the half of the state that receives about 20 percent of the precipitation.

- Recent studies identify a need for another 600,000 to one million acre-feet of raw water by 2030. **These figures do not include water needs that might be generated by the effects of climate change**, environmental and recreational uses, and energy development.

- By 2050 climate change could cause Colorado River flows to decline by 18 percent. Average Colorado Basin water storage could decline by 32 percent.